Studies of molecular interactions and proton transfer in biological membranes and models by nanoscale vibrational spectroscopy.

Membranes are essential components of cells. The cell membrane defines and encloses the cell, protects it from the surrounding environment and controls the passage of nutrients and stimuli from the outside world. Similarly, membranes inside the cell define organelles and functional compartments, and control the movement of molecules within the cell. In addition, membranes carry out another fundamental task, they store energy. They do so by acting as the capacitors of an electrical circuit, that is they accumulate electrical charges on the their opposite surfaces. Many of these charges are associated to H^+ ions. We understand well the mechanism by which the cell recovers the energy, by letting the excess of H^+ ions flow back across the membrane. However, H^+ ions also move along the plane of the membrane, without discharging the excess charge. We want the understand how this happens, by what mechanisms, and why. Is this only a way for the cell to optimize energy storage, or is it also used to transfer information? We will try to answer these questions by studying the mechanism used by H^+ ions to move in the plane of a membrane. We will do so by using new techniques that allow us to measure quantitatively the distribution and movement of H^+ ions along the membrane plane.